

SD 70-556-2

SATURN S-II
QUALITY ASSURANCE TECHNIQUES

NONDESTRUCTIVE TESTING PROCESSES

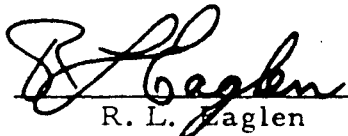
Volume II - Radiographic References

30 October 1970

Prepared by

H. H. Eller, F. E. Sugg

Approved by



R. L. Haglen
Director

Saturn S-II Quality Assurance

(NASA-CR-123488) SATURN S-2 QUALITY
ASSURANCE TECHNIQUES, NONDESTRUCTIVE
TESTING PROCESSES. VOLUME 2: RADIOGRAPHIC
REFERENCES H.H. Eller, et al (North
American Rockwell Corp.) 30 Oct. 1970 9 p 00/99

N72-74494

Unclas
38366



Space Division
North American Rockwell

PRICES SUBJECT TO CHANGE

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

TECHNICAL REPORT INDEX/ABSTRACT

ACCESSION NUMBER						DOCUMENT SECURITY CLASSIFICATION			
						UNCLASSIFIED			
TITLE OF DOCUMENT								LIBRARY USE ONLY	
SATURN S-II QUALITY ASSURANCE TECHNIQUES, NONDESTRUCTIVE TESTING PROCESSES VOLUME II - RADIOGRAPHIC REFERENCES									
AUTHOR(S)									
ELLER, H.H. AND SUGG F.E.									
CODE		ORIGINATING AGENCY AND OTHER SOURCES				DOCUMENT NUMBER			
QN085057		SPACE DIVISION OF NORTH AMERICAN ROCKWELL CORPORATION, SEAL BEACH, CALIFORNIA				SD 70-556-2			
PUBLICATION DATE				CONTRACT NUMBER					
30 OCTOBER 1970				NAS7-200					
DESCRIPTIVE TERMS									
SATURN S-II *QUALITY ASSURANCE TECHNIQUES *RADIOGRAPHIC REFERENCES									

ABSTRACT
<p>THIS VOLUME IS SUBMITTED TO NASA AS PART OF THE EFFORT BY NORTH AMERICAN ROCKWELL'S SPACE DIVISION TO DOCUMENT SPECIAL SKILLS DEVELOPED DURING THE SATURN S-II PROGRAM. THIS EFFORT PROVIDES DOCUMENTS WHICH WILL ENABLE QUALIFIED PERSONNEL UNFAMILIAR WITH THE PROGRAM TO CARRY OUT EFFICIENT OPERATIONS IN FUTURE S-II PRODUCTION.</p>

FOREWORD

This volume is submitted to the National Aeronautics and Space Administration as part of the effort by North American Rockwell Corporation's Space Division to document special skills developed during the Saturn S-II Program. This effort, performed under Contract NAS7-200, provides documents which will enable qualified personnel unfamiliar with the program to carry out efficient operations in future S-II production.

This is Volume II of S-II Nondestructive Testing Processes, which emphasizes radiographic film interpretation. The complete set includes:

S-II Nondestructive Testing Processes (SD 70-556)

- Vol. I - Requirements and Procedures
- Vol. II - Radiographic References

S-II Critical Process Control (SD 70-557)

- Vol. I - Adhesive Bonding
- Vol. II - Foam Insulation
- Vol. III - Primers and Coatings
- Vol. IV - Foil Seals and Potting
- Vol. V - Contamination
- Vol. VI - Chemical Processing
- Vol. VII - Metallic Materials
- Vol. VIII - Raw Material Control

CONTENTS

Section	Page
1.0 INTRODUCTION	1



1.0 INTRODUCTION

The ability of radiographic film interpreters to provide accurate and complete assessments of internal weld quality is dependent upon their knowledge and familiarity with the type of indications that might be encountered during routine evaluations. The film interpreter must be able to identify and classify all indications found on the radiographs, such as internal or surface discontinuities, actual voids, and indications caused by extraneous sources such as film-processing blemishes.

This section contains examples of typical radiographic indications that a radiographic film interpreter might encounter during the evaluation of aluminum alloy welds. Most of the examples are of weld discontinuities, although examples of indications caused by extraneous sources are also included.

The examples have been photographically reproduced from actual weld radiographs exposed during fabrication of the Saturn S-II. The reproduced examples have been enlarged to enhance their visibility for use as a training aid. The film density of the examples was established so they could be viewed under most any available light source.

The ability to reproduce a faint or very small radiographic image and still maintain a true likeness to the original image has always been a difficult task. The photographic method employed for the reproduction of the examples shown here is an improvement over previous results obtained with conventional radiographic reproducing film.

The discontinuities of interest on the examples are described; all other indications are not considered representative of that particular example.

A glossary of terms used to define the discontinuities in these examples follows:

Artifact	An indication that may be erroneously interpreted as a discontinuity.
Discontinuity	Any interruption in the normal physical structure or configuration of a component, such as cracks, porosity, or inclusions. A discontinuity may or may not affect the usefulness of a component.

Crack, crater	Crisscross or star cracking, usually at or just below the surface. Appears as a dark crisscross or star shape with ragged edge lines.
Crack, longitudinal	A crack running parallel with the weld, sometimes in the parent metal. Appears as a dark jagged line.
Crack, transverse	A crack running across the weld, sometimes in the parent metal. Appears as a dark jagged line.
Inclusion, less dense or inclusion, oxide	Usually aluminum oxides entrapped in the weld metal. Appears as dark irregular voids, sometimes with ragged edges and sharp angles.
Oxide, elongated or oxide, stringer	Usually aluminum oxides entrapped in the weld metal. Appears as a dark, narrow, irregular line.
Inclusion, more dense	Normally tungsten or some other more dense material entrapped in the weld metal. Appears as light spots in the weld metal.
Porosity, clustered	Gas entrapped in the weld metal. Appears as a group of three or more smooth, dark (small, medium, or large), round, or elongated voids.
Porosity, connected	Gas entrapped in the weld metal. Appears as dark, smooth, round, or elongated voids connected together.
Porosity, isolated	Gas entrapped in the weld metal. Appears as a single dark, smooth, round, or elongated void.
Porosity, linear	Gas entrapped in the weld metal. Appears as a series of three or more smooth, dark, round, or elongated voids in a line.

Porosity, tailed	Gas entrapped in the weld metal. Appears as a dark void with a sharp angle or small tail-like line leading from the void.
Incomplete fusion	Failure of weld metal to fuse with parent metal or self. Appears as one or more dark, wavy lines on either side of the weld.
Incomplete penetration	Failure to completely penetrate the joining parent metal surfaces. Appears as a dark, straight line in the center of the weld.
Undercut	Reduction in the thickness of the parent metal next to the weld bead on the torch side. Appears as a dark, broad line in the fusion zone.
Eutectic	Concentrations of copper/aluminum eutectic phase. Appears as more dense linear inclusion normally running diagonal or longitudinal to the weld bead.
Flowline or enigma	Appears on the radiograph as a smooth dark line accompanied by a light line. Similar to incomplete fusion, except that it appears in any part of the weld metal and is not considered rejectionable.

The following is a list and description of the subject matter contained in the reference radiographs on the following pages:

Frame Number and Description

1. Porosity, connected
2. Porosity, elongated and connected
3. Porosity, isolated and porosity, connected
4. Porosity, isolated
5. Porosity and more dense inclusion
6. Porosity, linear
7. Porosity, connected



8. Porosity, elongated
9. Porosity, tailed
10. Inclusions, oxide cluster with sharp angles
11. Inclusions, oxide and porosity cluster with sharp angles
12. Oxide, elongated
13. Oxide, elongated
14. Inclusions, more dense
15. Crack, longitudinal (to the vertical weld) at weld intersection
16. Crack, longitudinal at weld intersection
17. Cracks, transverse and crack, crater
18. Cracks, longitudinal and cracks, transverse
19. Crack, transverse
20. Incomplete penetration and incomplete fusion
21. Incomplete penetration and incomplete fusion
22. Incomplete fusion
23. Incomplete fusion
24. Incomplete fusion
25. Incomplete penetration and undercut
26. Incomplete penetration
27. Eutectic
28. Undercut
29. Flow lines
30. Flow lines



31. Flow line
32. Flow line in vertical weld
33. Metal shaving on weld
34. Artifact, film scratches
35. Artifact, roller marks from automatic film processor
36. Film overlap, causing density differential
37. Artifact, pressure mark from automatic film processor
38. Tape across weld
39. Artifact, crimp mark
40. Artifact, static electricity